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XXIV. "Experimental Inquiry into the Composition of some of the Animals fed and slaughtered as Human Food."

By J. B. LAWES, Esq., F.R.S., F.C.S., and J. H. GILBERT, Ph.D., F.C.S. Received June 17, 1858.

(Abstract.)

After alluding to the importance of the chemical statistics of nutrition in relation to physiology, dietetics and rural economy, and explaining that the branch of the subject comprehended in the present paper is that of *Animal Composition*, the authors proceed in the first place to state the general nature of their investigations, and the manner in which they were conducted.

To ascertain the quantitative relations, and the tendency of development, of the different parts of the system, the weights of the entire bodies, and of the several internal organs, also of some other separated parts, were determined in several hundred animals—oxen, sheep and pigs.

To determine the ultimate composition, and in a sense the proximate composition also, of oxen, sheep and pigs, and to obtain the results in such manner that they might serve to estimate the probable composition of the *Increase* whilst fattening, was a labour obviously too great to be undertaken with a large number of animals. Those selected were—a fat calf, a half-fat ox, a moderately fat ox, a fat lamb, a store or lean sheep, a half-fat old sheep, a fat sheep, a very fat sheep, a store pig, and a fat pig.

It is to the methods and the results of the analysis of these ten animals, to the information acquired as to the quantitative relation of the organs or parts in the different descriptions of animal, and their relative development during the fattening process, and to the application of the data thus provided, that the authors chiefly confine themselves in the present paper.

The analyses of the ten animals were planned to determine the actual and per-centage amounts—of water, of mineral matter, of total nitrogenous compounds, of fat, and of total dry substance—in the entire bodies, and in certain individual and classified parts of the animals. The water and mineral matter were for the most part determined in each internal organ, or other separated part. But, to

confine the labour within reasonable limits, and to facilitate as far as possible the perception of the practical and economic application of the results, the other constituents enumerated are given in—

1st. The collective “carcass” parts; that is, the frame with its covering of flesh and fat, which comprise the most important portions sold as human food.

2nd. The collective “offal” parts; including the whole of the internal organs, the head, the feet, and, in the case of oxen and sheep, the pelt and hair or wool.

3rd. The entire animal (fasted live-weight).

Referring first to the composition of the “*collective carcass parts*,” it appeared, comparing one animal with another, that there is a general disposition to a rise or fall in the per-centage of *mineral matter*, with the rise or fall in that of the *nitrogenous compounds*. In fact, all the results tended to show a prominent connexion between the amount of the mineral matters and that of the nitrogenous constituents of the body.

Comparing the relative proportions of *fat* and *nitrogenous compounds* in the respective “carcasses,” it appeared that, in every instance excepting that of the calf, there was considerably more of dry fat than of dry nitrogenous compounds. In the carcass of even the store or lean sheep, there was more than $1\frac{1}{2}$ times as much fat as nitrogenous substance; in that of the store or lean pig, twice as much. In the carcass of the half-fat ox, there was one-fourth more fat than nitrogenous matter; and in that of the half-fat sheep, more than twice as much.

Of the fatter animals, the carcass of the fat ox contained $2\frac{1}{3}$ times, that of the fat sheep 4 times, and that of the very fat sheep, 6 times as much fat as nitrogenous substance. Lastly, in the carcass of the moderately fat pig, there was nearly 5 times as much fatty matter as nitrogenous compounds.

From these facts it may be concluded, that in carcasses of oxen in reputed good condition, there will seldom be less than twice as much, and frequently nearly 3 times as much dry fat as dry nitrogenous substance. It may be presumed, that in the carcasses of sheep the fat will generally amount to more than 3, and frequently to 4 (or even more) times as much as the nitrogenous matters; and finally, that in the carcasses of pigs killed for fresh pork, there will seldom

be as little as 4, and in those fed for curing there will be more than 4 times as much fat as nitrogenous compounds.

The *fat* of the bones constituted but a small proportion of that of the entire carcasses; whilst the *nitrogen* of the bones amounted to a considerable proportion of the whole.

It appeared, that whilst the per-centage (in the carcasses) of both mineral and nitrogenous matters *decreased* as the animals matured, that of the fat very considerably *increased*. The increase in the per-centage of fat was much more than equivalent to the collective decrease in that of the other solid matters,—that is to say, as the animal matures, the per-centage in its carcass, of *total dry substance*—and especially of fat—much increases.

The carcass of the calf contained $62\frac{1}{4}$ per cent., that of the lean sheep $57\frac{1}{3}$ rd per cent., that of the lean pig $55\frac{1}{3}$ rd, and that of the half-fat ox 54 per cent. of water. In the carcass of the fat ox there were $45\frac{1}{2}$ per cent., in that of the fat lamb $48\frac{2}{3}$ rds per cent., in that of the half-fat old sheep $49\frac{2}{3}$ rds per cent., in that of the fat sheep $39\frac{2}{3}$ rds per cent., in that of the very fat sheep only 33 per cent., and in that of the moderately fattened pig only $38\frac{1}{2}$ per cent. of water. The bones of the carcasses contained a less proportion of water than the collective soft or edible portions.

It is inferred, that the average of carcasses of well-fattened oxen will contain 50 per cent., or rather more, of dry substance; that those of properly fattened sheep will contain more still—say 55 to 60 per cent.; those of pigs killed for fresh pork rather more than those of sheep; whilst the sides of pigs fed and slaughtered for curing will be drier still. Lamb-carcasses would seem to contain a smaller proportion of dry substance than those of either moderately fattened oxen, sheep, or pigs. Their proportion of bone was also comparatively high. Veal appeared to be the moistest of all. The carcass of the calf experimented upon, though the animal was considered to be well fattened, contained only $37\frac{3}{4}$ per cent. of dry substance. Its proportion of bone was also higher than in any of the other animals.

Next as to the composition of the *collective offal parts* (excluding the contents of stomachs and intestines), the results showed that in every case the per-centage of nitrogenous substance was greater, and that of the fat very much less, than in the collective carcass parts.

In oxen and sheep, the pelt, hair or wool, hoofs, stomachs and intestines, taken together, contained a large proportion of the total nitrogen of the offal parts. The portions of the nitrogenous offal parts of these animals, generally used for food, are, the head-flesh with tongue and brains, the heart, the liver, the pancreas, the spleen, the diaphragm, and sometimes the lungs. In the pig, the proportion of the nitrogenous offal generally eaten, is greater than in the other animals; but its proportion of fat is generally also greater.

With the higher per-centage of nitrogenous substance, and the less per-centage of fat, in the collective offal parts, they had invariably a less per-centage of total dry substance, and therefore more of water, than the collective carcass parts.

From the composition of the *entire bodies* of the animals analysed, it is estimated, that of *mineral matter*, the average amount, in *store* or *lean* animals, will probably be, in oxen $4\frac{1}{2}$ to 5 per cent., in sheep 3 to $3\frac{1}{2}$ per cent., and in pigs $2\frac{1}{2}$ to 3 per cent. As an average estimate for the *mineral* matter in *fattened* animals, the results indicated $3\frac{1}{2}$ to 4 per cent. in the live-weight of calves and oxen, $2\frac{1}{2}$ to $2\frac{3}{4}$ per cent. in that of sheep and lambs, and $1\frac{1}{4}$ to $1\frac{3}{4}$ per cent. in that of pigs.

Of total *nitrogenous compounds*, there were in the fasted live-weight of the fat ox $14\frac{1}{2}$ per cent., in that of the fat sheep $12\frac{1}{4}$ per cent., in that of the very fat one not quite 11 per cent., and in that of the moderately fattened pig about the same, namely, 10·87 per cent. The leaner animals analysed contained from 2 to 3 per cent. more nitrogenous substance than the moderately fattened ones.

The *Fat* formed the most prominent constituent of the dry or solid substance of the entire animal bodies. The fat calf alone contained less total fat than total nitrogenous compounds. Of the other professedly fattened animals, the entire bodies of the fat ox and fat lamb contained about 30 per cent., that of the fat sheep $35\frac{1}{2}$ per cent., that of the very fat sheep $45\frac{3}{4}$ per cent., and that of the moderately fat pig $42\frac{1}{4}$ per cent. of dry fat.

The average composition of the six animals assumed to be well fattened, showed, in round numbers, 3 per cent. of mineral matter, $12\frac{1}{2}$ per cent. of nitrogenous compounds, and 33 per cent. of fat, in their standing or fasted live-weight.

All the experimental evidence conspired to show, that the so-called "*fattening*" of the animals was properly so designated. During the feeding or fattening process, the per-centage of the collective dry substance of the body considerably increased; and the fatty matter accumulated in much larger proportion than the nitrogenous compounds. The *increase* itself must therefore show a less per-centage of nitrogenous substance (and of mineral matter also), and a higher one of both fat and total dry substance, than the whole body of the fattened animal.

The knowledge thus acquired of the composition of animals in different conditions of maturity, was next employed as a means of estimating the composition of the increase gained in passing from one given point of progress to another.

To this end, the composition of the animals analysed in the lean condition, was applied to the known weights of numbers of animals of the same description, assumed to be in a similar lean condition; and the composition of the fat animals analysed was in like manner applied to the weights of the same series of animals after being fattened. Deducting the amount of the respective constituents in the lean animals, from that of the corresponding constituents in the fat ones, the *actual* amount of each constituent gained was determined. The weight of the gross increase being also known, its estimated *per-centage* composition was thus a matter of easy calculation. The composition of the *increase* of 98 fattening oxen, 349 fattening sheep, and 80 fattening pigs (each divided into numerous lots), was estimated in the manner indicated; and as a control, a statement is given of the composition of the *increase* of the single analysed fat pig, which, at the time it was put to fatten, corresponded in weight and other particulars most closely with the one analysed in the lean condition.

It is concluded, that the *increase* in weight of *oxen*, taken over six months or more of the final fattening period, may be estimated to contain from 70 to 75 per cent. of total dry substance; of which 60 to 65 parts will be fat, 7 to 8 parts nitrogenous substance, and 1 to $1\frac{1}{2}$ mineral matter.

On the same plan of calculation, the final *increase* of *sheep*, feeding liberally during several months, will probably consist of 75 per cent., or more, of total dry substance; of this, 65 to 70 parts

will be fat, 7 to 8 parts nitrogenous compounds, and perhaps $1\frac{1}{2}$ part mineral matter.

The *increase of pigs*, during the final two or three months of feeding for fresh pork, may be taken at 70 to 75 per cent. total dry substance, 65 to 70 per cent. fat, 6 to 8 per cent. nitrogenous substance, and less than 1 per cent. of mineral matter. The increase over the last few months of high feeding, of pigs fed for curing, will doubtless contain a higher per-centage of both fat and total dry substance, and a lower one of both nitrogenous compounds and mineral matter, than that of the younger and more moderately fattened animal.

As a general result, it appears that about $\frac{3}{4}$ ths of the gross increase in live-weight, of animals feeding liberally for the butcher, will be dry or solid matter of some kind. About $\frac{2}{3}$ rds of the gross increase will be dry fat; only about 7 or 8 per cent. of the gross increase (and scarcely more than $\frac{1}{10}$ th of the total dry substance) will be nitrogenous compounds; and seldom more than $1\frac{1}{2}$, and frequently less than 1 per cent. mineral matter.

In the case of most of the sheep, and of all the pigs, the composition of whose increase was estimated, the amounts of mineral matter, of nitrogenous compounds, of non-nitrogenous organic substance, of total dry substance, and sometimes of fat, which were consumed during the fattening period, were determined; so that the means are at command for studying the quantitative relation of the constituents estimated to be stored up in the increase, to those consumed in the food which produced it.

Taking first the proportion of each class of constituents stored up *for 100 of the same consumed*, it is concluded, that in the case of sheep, liberally fed on a mixed diet of dry and succulent food, the increase of the animal will perhaps generally carry off less than 3 per cent. of the consumed mineral matter—somewhere about 5 per cent. (varying according to the proportion in the food) of the consumed nitrogenous compounds, and about 10 parts of fat for 100 non-nitrogenous substance in the food; and lastly, that for 100 of collective dry substance of food consumed, there will be, in Sheep, about 8 or 9 parts of dry matter in increase stored up.

The food of the fattening pig contained a much smaller proportion of indigestible woody fibre than that of the sheep; and it appeared that the pig appropriated to its increase a much larger proportion of

the organic constituents of its food than the sheep. The average of the estimates for pigs, showed about 17 parts of dry substance of increase stored up, for 100 of collective dry matter of food consumed. For 100 of non-nitrogenous organic constituents in food, about 20 parts of fat were stored up. Of nitrogenous compounds, when the food consisted of about the usual proportions of the leguminous seeds and cereal grains, from 5 to 7 or 8 parts were stored up for 100 consumed. When the leguminous seeds predominated, the *proportion* of the consumed nitrogen stored up was less; and when the cereal grains predominated, it was greater. The estimates showed, that on the average of the cases, there were 4 or 5 times as much fat stored up in increase, as there was of fatty matter supplied in the food. There was obviously therefore a *formation* of fat in the animal body.

Reckoning the amount of the respective constituents of increase stored up, *for 100 of the collective dry substance of the food consumed*, the general result was as follows:—It appeared, that of the about 9 parts of dry increase, in sheep liberally fed on corn or oil-cake and succulent roots, for 100 of dry food consumed, about 8 parts were non-nitrogenous substance, that is, *fat*. There was therefore only about 1 part stored as nitrogenous and mineral matters taken together. The average of the estimates showed the produce of 100 of the collective dry substance of the consumed food of sheep to be—about, 0·2 part of mineral matter, 0·8 part nitrogenous compounds, and 8 parts fat, stored up; leaving therefore about 91 parts to be expired, perspired, or voided.

Taking the average of all the estimates of this kind relating to *pigs*—of the $17\frac{1}{4}$ parts of dry increase for 100 of dry matter of food consumed, about $15\frac{3}{4}$ parts were estimated as fat, rather more than $1\frac{1}{3}$ rd part nitrogenous substance, and an insignificant amount as mineral matter. On this plan of calculation, therefore, there would appear to be, in the case of fattening pigs, only from 82 to 83 parts of food-constituents expired, perspired, or voided, for 100 of the collective dry substance of food consumed.

It is obvious that the ultimate composition of the dry substance of increase must be very different from that of the 100 of dry substance consumed. This is strikingly illustrated in the case of the fat. In most of the experiments with pigs, the fatty matter in the

food was determined. On the average of the cases it amounted to less than $\frac{1}{4}$ th as much as was estimated to be stored up in the increase of the animals. There was obviously therefore a *formation of fat in the body*, from some other constituent or constituents of the food. Supposing the $\frac{3}{4}$ ths or more of the stored-up fat which must have been formed in the body to have been produced from *starch*, it was estimated that it would require $2\frac{1}{2}$ parts of starch to contribute 1 part of produced fat. Accordingly, it would appear that a much larger proportion of the consumed dry matter is, as it were, directly engaged in the production of the dry fatty increase, than is represented by the amount of the dry increase itself.

Thus, taking the average of the cases in which the fatty matter in the food of the pigs was determined, it was estimated that 17·4 parts of dry increase were produced for 100 of dry matter of food consumed. Of the 17·4 parts of dry increase, 16·04 are reckoned as fat. But there were only 3·96 parts of ready-formed fatty matter supplied in the food. At least 12·08 parts of fat must therefore have been produced from other substances. If from starch, it would require (at the rate of $2\frac{1}{2}$ parts of starch to 1 of fat) 30·2 parts of that substance for the formation of 12·08 parts of the produced fat. The ready-formed fat and the starch, together, thus supposed to contribute to the 16·04 parts of fat in the increase, would amount to 34·16 parts out of the 100 of dry matter of food consumed. But there were, further, 1·36 part of nitrogenous and mineral matters stored up in the increase. In all, therefore, 35·52 parts out of the 100 of gross dry matter consumed, contributed, in this comparatively direct manner, to the production of the 17·4 parts of gross dry increase.

According to the illustration just given, it appears that there was pretty exactly twice as much of the dry substance of the food, involved in the direct production of the increase, as there was of dry increase itself; hence instead of their being, as before estimated, 82 to 83 parts of the consumed dry matter expired, perspired, or voided, without as it were being directly involved in the production of the increase, it is to be inferred that, in the sense implied, only about 65 parts were so expired, perspired, or voided.

It having been thus found that by far the larger proportion of the solid increase of the so-called fattening animals is really *fat*

itself,—as moreover, it is probable that, at least in great part, the fat formed in the body is normally derived from starch, and other non-nitrogenous constituents of the food—and since the current fattening foods contain such a very large amount of nitrogen compared with that eventually retained in the increase—it can hardly be surprising that, contrary to the usually accepted opinions, the comparative values of our staple food-stuffs are much more nearly measurable by their amount of digestible and assimilable non-nitrogenous constituents, than by that of the digestible and assimilable nitrogenous compounds.

In order to determine the relative development of the several organs and parts in different descriptions of animals, and in animals of the same description in different conditions of growth and maturity, the weights alive, and of the separate internal organs and some other parts, of 16 calves, heifers and bullocks, of 249 sheep, and of 59 pigs, were taken.

It appeared that in oxen the stomachs and contents constituted about $11\frac{1}{2}$, in sheep about $7\frac{1}{2}$, and in the pig only about $1\frac{1}{4}$ per cent. of the entire weight of the body. The amounts of the intestines and their contents stood in the opposite relation. They amounted in the pig to about $6\frac{1}{4}$, in the sheep to about $3\frac{1}{2}$, and in the oxen to only about $2\frac{3}{4}$ per cent. of the whole body. These facts are of considerable interest, when it is borne in mind that in the food of the ruminant there is so large a proportion of indigestible woody fibre, and in that of the well-fed pig a comparatively large proportion of starch—the primary transformations of which are supposed to take place chiefly after leaving the stomach, and more or less throughout the intestinal canal.

Taken together, the stomachs, small intestines, large intestines, and their respective contents, constituted, in oxen more than 14 per cent., in sheep a little more than 11 per cent., and in pigs about $7\frac{1}{2}$ per cent. With these great variations in the proportion in the different descriptions of animals, of these receptacles and first laboratories of the food (with their contents), the further elaborating organs, if we may so call them (with their fluids), appear to be much more equal in their proportion in the three cases. This is approximately illustrated in the fact, that taking together the recorded per-centages of “heart and aorta,” “lungs and windpipe,” “liver,” “gall-bladder

and contents," "pancreas," "milt or spleen," and the "blood," the sum indicated is for the oxen about 7 per cent., for the sheep about $7\frac{1}{4}$ per cent., and for the pigs about $6\frac{2}{3}$ rds per cent. Excluding from this list the blood, which was more than $\frac{1}{3}$ rd of a per cent. lower in amount in the pigs than in the other animals, the sums of the per-centages of the other parts enumerated would agree even much more closely for the three descriptions of animal.

With regard to the influence of progression in maturity and fatness of the animal, upon the relative development of its several parts, the results showed that the internal organs and other offal-parts pretty generally *increased in actual weight* as the animals passed from the lean to the fat or to the very fat condition. The *per-centage proportion* to the whole live-weight of these offal-parts as invariably *diminished* as the animals matured and fattened. The carcasses, on the other hand, invariably increased, not only in *actual weight*, but in *proportion* to the whole body.

The conclusion is, that in the feeding or fattening of animals, the apparatus which subserves for the reception and elaboration of the food does not increase commensurately with those parts which it is the object of the feeder to store up from that food. These parts are comprised in the "carcass" or frame-work, with its covering of flesh and fat. Of the carcasses which thus constitute the greater part of the increase, the nitrogenous portions increase but little, whilst the *fat* does so in very much larger proportion. Of the internal parts, again, it is also the *fat* which increases most rapidly.

The maturing process consists, then, in diminishing the proportional amount in the whole body, of the collective muscles, tendons, vessels, fleshy organs, and gelatinous matters—the motive and functional, or so to speak, working parts of the body—the constituents of which alone can increase the amount of or replace the transformed portions of similar matters in the human body. It consists, further, in increasing very considerably the deposition of *fat*—one of the *non-flesh-forming*, but most concentrated of the respiratory and fat-storing constituents of human food.

It is then in our *meat-diet*, of recognized good quality, to which is generally attributed such relatively high *flesh-forming* capacity, that we carefully store up such a large proportion of *non-flesh-forming*, but concentrated respiratory material.

One of the most important applications which can be made of a knowledge of the composition of the animals which constitute the chief sources of our animal food, is to determine the main points of distinction between such food and the staple vegetable substances which it substitutes or supplements in an ordinary mixed diet.

By the analysis of some of the most important animals fed and slaughtered as human food, it was found that the *entire bodies*, even when in a reputed lean condition, may contain more dry fat than dry nitrogenous substances. Of the animals "ripe" for the butcher, a bullock and a lamb contained rather more than twice, a moderately fat sheep nearly three times, and a very fat sheep and a moderately fat pig about four times as much dry fat as dry nitrogenous matter. Of the professedly fattened animals analysed, a fat calf alone contained rather less fat than nitrogenous compounds.

It was estimated, that of the whole *nitrogenous substances* of the body, 60 per cent. in the case of calves and oxen, 50 per cent. in lambs and sheep, and 78 per cent. in pigs, would be consumed as human food. Of the total *fat* of the bodies, on the other hand, it was supposed, that in calves and lambs 95 per cent., in oxen 80 per cent., in sheep 75 per cent., and in pigs 90 per cent. would be so applied.

Assuming the proportional consumption of the fat and nitrogenous compounds to be as here estimated, there would be in the fat calf analysed $1\frac{1}{2}$ time, in the fat ox $2\frac{3}{4}$ times, in the fat lamb, fat sheep, and fat pig nearly $4\frac{1}{2}$ times, and in the very fat sheep $6\frac{1}{4}$ times as much dry fat as dry nitrogenous or flesh-forming constituents consumed as human food.

It would perhaps be hardly anticipated, that in the staple of our meat-diet, to which such a high relative flesh-forming capacity is generally attributed, there should be found such a high proportion of non-flesh-forming to flesh-forming matter as above indicated. The result of such a comparison as present knowledge permits in regard to the same point between the staple of our animal food and the more important kinds of vegetable food, will certainly not be less surprising

Of the staple *vegetable* foods, *wheat-flour bread* is, at least in this country, the most important. It will be interesting, therefore, to contrast with this substance the estimated consumed portions of the

analysed animals. To this end some assumption must be made as to the relative values (on the large scale), for the purposes of respiration and fat-storing, of the starch and its analogues in bread, and the fat in meat. It is assumed that, in round numbers, 1 part of fat may be considered equal to $2\frac{1}{2}$ parts of starch in these respects. If, therefore, the quantity of fat in the estimated consumed portions of the analysed animals be multiplied by 2·5, it is brought to what may be conveniently called its "*starch-equivalent*;" and in this way the Meat and the Bread can be easily compared with one another in regard to the relation of their flesh-forming, to their respiratory and fat-forming capacities.

Reckoning the amount—say 1 per cent.—of fat in Bread itself (and it probably averages not more than $\frac{1}{2}$ per cent.), to be equal to $2\frac{1}{2}$ parts of starch, and adding this to the amount of the actual starch and allied matters which it on the average contains, the calculation gives—assuming this *starch-equivalent* to represent specially the respiratory and fat-forming, and the nitrogenous substances, the flesh-forming matter—6·8 parts of respiratory and fat-forming to 1 of flesh-forming material in *Bread*.

Taking the relation of the one class of constituents to the other, in the estimated total consumed portions of the animals assumed to be in fit condition for the butcher, there was only one case—that of the fat calf—in which the proportion of the so measured respiratory and fat-forming to the flesh-forming capacity was in this our meat-diet lower than in Bread. In the estimated total consumed portions of the fat ox, the proportion of the *starch-equivalent* of non-flesh-forming matter to 1 of nitrogenous compounds, was 6·9, or rather higher than in Bread. In the estimated consumed portions of the fat lamb, the fat sheep, and the fat pig, the proportion was more than $1\frac{1}{2}$ time as great as in Bread; and in those of the extra fat sheep it was more than twice as great. Taking the average of the 6 cases, there were nearly 10 parts of *starch-equivalent* to 1 of nitrogenous compounds, against 6·8 to 1 in Bread. In the half-fat ox, and the half-fat old sheep, neither of which were in the condition of fatness of such animals as usually killed, the relation of the *starch-equivalent* to the nitrogenous compounds (assuming only the same proportion of the total fat as before to be eaten), was in the former considerably, and in the latter slightly lower than in Bread, namely,

as 3·83 to 1 in the half-fat ox, and as 6·28 to 1 in the half-fat old sheep.

It will perhaps be objected, that when animals are so far fattened as to attain the relations above stated, the feeder is simply inducing disease in the animals themselves, and frustrating that which, it is considered, should be the special advantage of a meat-diet, namely, the increase in the relative supply of the flesh-forming constituents in our food. It cannot be doubted, however, that in animals that would be admitted, by both producer and consumer, to be in only a proper condition of fatness, there would be a higher relation of non-nitrogenous substance, in its respiratory and fat-forming capacity to flesh-forming material, in their total consumed portions, than in the average of our staple vegetable foods. It may be true, that with the modern system of bringing animals very early forward, the development of fat will be greater, and that of the muscles and other nitrogenous parts less than would otherwise be the case; but it is certain, that if meat is to be economically produced, so as to be within the reach of the masses of the population, it can only be so on the plan of early maturity. Nor will it be questioned, that the admixture with their otherwise vegetable diet, of the meat so produced is, in practice, of great advantage to the health and vigour of those who consume it.

It is true that individual joints or other parts, as sold, will frequently have a less proportion of fat to flesh-forming matter than, according to the above supposition, will be consumed. Some fat will also be removed in the process of cooking. But this portion will generally still be consumed in some form. And where fresh meat is bought, so also are suet, lard, and butter, which, either add to the fatness of the cooked meats, or are used further to reduce the relative flesh-forming capacity of the collaterally consumed vegetable foods.

It would, indeed, appear to be unquestionable, that the influence, on the large scale, of the introduction of animal food to supplement our otherwise mainly farinaceous diet, is to reduce and not to increase the relation of the nitrogenous or peculiarly flesh-forming to the non-nitrogenous constituents (reckoned in their respiratory and fat-forming capacity) of the food consumed.

That, nevertheless, a diet containing a due proportion of animal

food is, for some reason or other, generally better adapted to meet the collective requirements of the human organism than an exclusively bread or other vegetable one, the testimony of common experience may be accepted as sufficient evidence. Whatever may prove to be the exact explanations of the benefits arising from a mixed animal and vegetable diet, it is at any rate pretty clear, that, independently of any difference in the physical, and perhaps even chemical relations of the nitrogenous compounds, they are essentially connected with the amount, the condition, and the distribution of the *fat* in the animal portions of the food.

Fat is the most concentrated respiratory, and of course fat-storing material also, which our food-stuffs supply. It cannot be doubted that, independently of the mere supply of constituents, the conditions of concentration, of digestibility, and of assimilability of our different foods must have their share in determining the relative values, for the varying exigences of the system, of substances which, in a more general or more purely chemical sense, may still justly be looked upon as mutually replaceable.

By the aid of chemistry it may be established that, in the admixture of animal food with bread, the relation (in respiratory and fat-forming capacity) of the non-flesh-forming to the flesh-forming substances will be increased, and, further, that in such a mixed diet the proportion of the non-flesh-forming constituents, which will be in the concentrated form, so to speak, of *fat itself*, will be considerably greater than in bread alone. Common experience also testifies to the fact of advantages so derived. It remains to Physiology to lend her aid to the full explanation of that which Chemistry and common usage have thus determined.

COMMUNICATIONS RECEIVED SINCE THE END OF THE SESSION.

- I. Note "On the Formation of the Peroxides of the Radicals of the Organic Acids." By B. C. BRODIE, F.R.S., Professor of Chemistry in the University of Oxford. Received July 22, 1858.

The researches of Gerhardt showed a close resemblance which exists between the monobasic organic acids and the metallic protoxides. We have the chloride of acetyl corresponding to the chloride of the